NOTES ON

FIVE YEARS' EXPERIMENTS

ON

HOP MANURING

CONDUCTED AT

GOLDEN GREEN, HADLOW, TONBRIDGE,

BY

DR. BERNARD DYER,

Consulting Chemist to the Essex, Leicester and Devon Agricultural Societies; District Agricultural Analyst for the Counties of Bedford, Cornwall, Essex, Hants, Herts, Leicester, Rutland, West Suffolk, and East Sussex.

Reprinted from
THE AGRICULTURAL GAZETTE,
A WEEKLY JOURNAL OF
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Hop Manuring Experiments.

By Dr. BERNARD DYER.

A year ago I recorded the results of several years' continuous experiments on the manuring of hops, carried out under my superintendence by my friend Mr. Shrivell, of Golden Green, Hadlow, near Tonbridge. I have now to continue the record. The object of the experiments, as previously explained, has been a simple one, viz., to ascertain how far nitrate of soda, in the presence of an abundant supply of phosphates and potash, can be advantageously used as a source of nitrogenous food for hops. For many years there has been prevalent among hop-growers an idea that nitrate of soda is an unsafe manure for hops, and likely to injure their quality. On the other hand, the consumption of nitrate of soda in our hop gardens has, of late, been steadily increasing. Nevertheless, a very large number of hop-growers, while freely using nitrogenous manures of other kinds, fear to make use of nitrate of soda.

As I pointed out last year, it is probable that this widely-spread distrust of nitrate as a hop manure is largely due to the fact that nitrate of soda, like many other nitrogenous manures, has in the past been misused, by being applied without a sufficient quantity of phosphates. For many years

hop-growers, who regularly used a variety of more or less concentrated nitrogenous manures, chiefly of a slowly-acting kind, such as shoddy, woollen rags, hoof and horn-parings, feathers, fur trimmings, and the like, have systematically neglected the use of phosphatic manure. Those who used rape dust, fish guano, and purchased dung have, indeed, in the form of these manures, been applying phosphates to their land, but still in quantities quite insufficient to balance the nitrogen contained in the fertilisers used; and it is, comparatively speaking, only in recent years that the use of really phosphatic manures, such as superphosphate, dissolved bones, Peruvian guano, bone dust, or basic slag, has tended to become at all general among hop growers.

For years past the supply of nitrogen, being excessive in relation to the supply of phosphates, was limited in its utility; and though, when it was in the form of such slowly-acting manures as those above enumerated, the excess might often do little harm, yet, if the excessive quantity of nitrogen, unaccompanied by phosphates, were supplied in the more active form of sulphate of ammonia, or in the still more active form of nitrate of soda, the plant would naturally be encouraged by the abundance of soluble nitrogenous food to make a rapid growth that was incapable of being carried to a proper conclusion, on account of the lack of mineral food. Such spasmodic and irrational manuring might naturally be expected to produce a forced overgrowth of bine and inferior hops. Such cases, however, are in no way applicable as precedents in considering the action of soluble manures like nitrate of soda and sulphate of ammonia, when applied in conjunction with proper quantities of phosphates, potash, and, if necessary, lime.

As I have also before pointed out, another source of distrust of nitrate of soda is no doubt the fact that it has been frequently applied too late in the season, with the result of delaying the ripening period, a result which, in many seasons, is, as hop-growers well know, highly undesirable.

That nitrate of soda possesses any specific direct influence on the hop plant, apart from what is due to its ready availability and concentration, is an idea for which there would seem to be no foundation. Ultimately all other forms of nitrogenous manure are converted into nitrate in the soil. Some—such as woollen rags, horn shavings, or hoof-parings—are only converted into nitrate after a considerable time; fish guano, rape dust, and dried blood require less time; and sulphate of ammonia, and the ammonia salts in guano, require still less, being chemically much nearer to the nitrate stage. In warm and moist weather these latter are converted into nitrate with fair rapidity, and there is no chemical difference between them and nitrate when they actually reach that stage of plant food.

It would seem, therefore, that if nitrate of soda has in some hands proved hurtful, it is (1) because it has been applied without a proper quantity of phosphates or potash, or (2) because it has been applied too abundantly, or (3) because it has been applied at the wrong time.

In the experiments at Hadlow, we have been endeavouring to solve the question as to the extent to which it is possible to profitably apply nitrate of soda to hops, and when it is best applied. For this purpose, it has been necessary to make the experiments as simple and as free from complication as possible, and no attempt has been made to compare the results obtained from nitrate of soda with those which would

have been obtained with like quantities of nitrogen supplied in the form of sulphate of ammonia, Peruvian guano, rape cake, &c.

It is not, of course, to be supposed that any hop-grower would year after year use, as we are using, nothing but phosphates, potash, and nitrate of soda in his hop gardens. Miscellaneous feeding is probably good for plants as well as for animals, and the quantity of nitrate of soda to be used in a system of miscellaneous manuring will obviously depend on the quantity of nitrogen supplied in other forms.

In addition to our purely chemically manured plots, however, we have had each year, for purposes of general comparison, a trial plot manured solely with dung, and incidentally we have been able also to institute comparisons between the yield of our various experimental plots and the yield of the remaining portion of the field, and sometimes with the yield of certain othe parts of the farm, obtained under miscellaneous manuring similar to that followed in ordinarily accepted hop-growing practice.

Our experiments began at the end of 1894, when a garden of young Fuggles hops, about to enter the first year of poling, was selected for the purpose. Our experimental plots are each one-sixth of an acre in area, and they run parallel with one another, there being four rows of hills in each. During the first season all the plots were limed and dunged. In the second, third, and fourth seasons no dung has been used on six of the plots, which have been treated with purely chemical fertilisers, phosphates having been abundantly supplied every year in the alternating forms of superphosphate and basic slag. Potash also has been supplied—kainit in 1895, muria e of potash in 1896, sulphate of potash in 1897 and 1898, an kainit in 1899.

The general scheme of experiment is that on one plot phosphates and potash are applied without any nitrogen, while on five other plots the phosphates and potash are supplemented by nitrate of soda in quantities varying from 2 cwt. per acre up to 10 cwt. per acre. The heavier dressings of nitrate are for the most part applied in successive doses of 2 cwt. per acre.

In my article of a year ago I gave a general description of the results of the experiments as far as they had then gone, giving full details of the crops of 1896, 1897, and 1898. I have now to record the results obtained during the past year, 1899, but may first briefly summarise our earlier experiences.

In the first year we did not begin to apply our nitrate until May, a very usual time for top-dressing, and the last dressings went on as late as August. The summer of 1895 was a very dry one, and the greater part of the nitrate failed to produce any effect at all, the crop being from 11 to 13 cwt. of hops per acre, without any consistent difference being shown between any of the differently manured plots. In 1896 we began to apply the nitrate earlier, viz., in February, and finished dressing in June. We got better results, but nitrate in excess of 2 cwt. per acre did no additional good. Two cwt. of nitrate of soda per acre, in conjunction with phosphates and potash, gave 16½ cwt. of hops per acre, as against 13 cwt. per acre grown on the rest of the field with the aid of dung. In 1897 we also applied our first dressing of nitrate in February, but finished dressing at the end of May. The results were far more satisfactory and progressive. In 1898 we applied the first dressing earlier still, viz., in the third week in January, and the last towards the middle of May, and the results were yet more satisfactory.

In 1899 our first dressing of nitrate went on at the beginning of January, and the last at the beginning of April. The actual dates of nitrate sowing in each of the last four years are shown in the following table :—

	1896.	1897.	1898.	1899.
Date of first nitrate dressing (B to F)	Feb. 12 ...	Feb. 22 ...	Jan. 20 ...	Jan. 4
Date of second nitrate dressing (C to F)	Mar. 20 ...	Mar. 20 ...	Feb. 25 ...	Feb. 1
Date of third nitrate dressing (D to F)	Apl. 14 ...	Apl. 12 ...	Mar. 29 ...	Mar. 1
Date of fourth nitrate dressing (E and F)	May 13 ...	May 1 ...	Apl. 22	Apl. 1
Date of fifth nitrate dressing (F)	June 23 ...	May 25 ...	May 11	

The year 1899 has been a year of extraordinary natural productivity.

To illustrate this, it may be recalled that our A plot has received no nitrogenous manure of any kind since 1895, when it received an ordinary dressing of dung. Ever since, it has received every year either superphosphate or basic slag, with a dose of potash salts, but no nitrate or other nitrogenous manure. In 1897 and 1898 this plot only produced 7½ and 8¼ cwt. of hops per acre, while our best nitrated plot produced in the same two years 13½ and 15¼ cwt. per acre, there being, therefore, a difference of 6 cwt. and 7 cwt. per acre due to the use of nitrate in addition to the phosphates and potash. In 1899, however, this plot A, which might have been supposed to be, from a hop-growing point of view, in a state of nitrogen starvation, actually produced over a ton of hops per acre—though, as we shall see hereafter, of but poor quality. Now, a ton of hops per acre certainly cannot be grown without a very good supply of nitrogen from somewhere, and, as no nitrogen had been added to the soil since 1895, the natural capital of organic nitrogen in the soil and

the residue of the dung applied in 1895 must have been the sources drawn upon, though for two years previously these had sufficed to produce but little more than half a crop. The phenomenon observed on this one-sixth of an acre is no doubt due to the same natural causes that produced the abnormally heavy crop in 1899 over a large area in Kent and Sussex; and it is of great interest to inquire what these causes may have been.

One of our plots which, without chemical fertilisers, has every year received thirty loads of London dung per acre, had given in 1897 and 1898—when the summers were very dry—almost as bad an account of itself as the plot altogether destitute of nitrogenous manure, producing quite a paltry crop compared with that produced by phosphates, potash, and nitrate. In 1899, however, this dunged plot behaved in an altogether exceptional manner, and did as well for quantity as any of our plots, producing 24½ cwt. of hops per acre, though, as we shall see, the quality was poor compared with that of the nitrated and phosphated hops. The same natural influences, therefore, that produced the extraordinary yield of over a ton per acre on the nitrogen-starved plot produced still more marked results on the dunged plot.

I think that much light is thrown on the matter by going back to 1898, and considering the weather then experienced. We had in 1898 a very hot summer, followed by an unusually warm autumn, affording a long and favourable time for the natural nitrification of the organic nitrogen of the soil, so that the land must have been unusually well supplied with natural nitrates by the time that winter arrived, if, indeed, the term winter can properly be applied to such mild weather as was experienced during the calendar winter months of 1898-99.

In the ordinary course of things, the nitrates thus formed would have been to a large extent washed down through the soil into the drains during the winter and spring rains; but over a very large area of the hop-growing country the dry weather of several years had reduced both soils and subsoils to a very dry condition, and the rain that fell in the winter of 1898-99, and in the early spring months of the latter year, was not sufficient at any time—at Hadlow, at all events—to cause the drains to run. Ponds and ditches were dry during the greater part of 1899 that had not been dry for years before. Not only, therefore, must there have been an exceptionally large production of soil nitrates, but an unusually large proportion of the nitrates produced must have remained in the surface soil and in the upper subsoil, within reach of the crop of 1899, so that every hop garden, apart from any application of manure in 1899, must have been in the position of having received, by natural agency, an extensive dressing of nitrate. When these conditions were followed by good growing weather and by a most satisfactory scarcity of insect pests, it is after all not remarkable that even nitrogen starved land, like our Plot A, should produce a fine crop of hops, or that our Plot X, with its residues of unutilised dung to supply additional material for nitrification, should have given so excellent an account of itself.

An examination of our results for the year, however, will show that, even under the highly advantageous natural conditions that prevailed, nitrate of soda proved a valuable addition to the natural resources of the soil, the quantity of hops produced on the nitrated plots being from 2 to 4¼ cwt. per acre in excess of the crop produced without artificially applied nitrogen, while the good effect in quality, as will be seen later, was of even greater importance.

In the following table I have set out in detail the results of the four crops from 1896 to 1899 inclusive, together with the average yield of each plot for the four years.

FUGGLES HOPS.

Plot.	Annual dressing per acre.	1896. Cwt.	1897. Cwt.	1898. Cwt.	1899. Cwt.	Average of 4 years. Cwt.
		Weight of kiln-dried hops per acre.				
A.	*Phosphates and potash	13½	7½	8¼	20¼	12½
B.	Phosphates, potash, and 2 cwt. nitrate of soda	16½	9¼	10¼	22¼	14½
C.	Phosphates, potash, and 4 cwt. nitrate of soda	16½	12	12½	23	16
D.	Phosphates, potash, and 6 cwt. nitrate of soda	15¼	13	13	22½	16
E.	Phosphates, potash, and 8 cwt. nitrate of soda	15	13½	15¼	23½	16¾
F.	Phosphates, potash, and 10 cwt. nitrate of soda	15¾	13	15	24½	17
X.	† 30 loads London dung... ...	13	8	9¾	24½	13¾
S.	Rest of Field.—15 cwt. basic slag, ½ ton of fish guano in autumn, ½ ton of fish guano in spring, and 4 cwt. nitrate of soda	—	—	13¼	—	—
S.	Rest of Field.—20 loads dung, 6 cwt. superphosphate, and 6 cwt. nitrate of soda	—	—	—	24½	—
	Rainfall from January to end of September	16 in.	18 in.	11 in.	17 in.	15½ in.

* 8 cwt. superphosphate and 2 cwt. muriate of potash per acre in 1896; 10 cwt. basic slag and 2 cwt. sulphate of potash in 1897; 8 cwt. superphosphate and 1 cwt. sulphate of potash in 1898; and 10 cwt. basic slag and 5 cwt. kainit in 1899.

† About 15 tons.

Quantity, however, is far from being the chief consideration in hop-growing, and the first question that any experienced reader will ask is naturally as to the quality of the produce of the various plots. As in 1898, we have again taken the best practical steps to arrive at a fair comparison between the quality of the hops grown on the various plots. The whole produce of each plot was dried and packed separately, and duplicate samples were drawn in the ordinary way in which samples are drawn for market purposes. One set of samples, with certain other samples from other parts of the farm for comparison, were submitted

to Mr. Alfred C. Chapman, F.I.C., of 23, Leadenhall Street, London, a gentleman of well-known chemical authority in connection with brewing matters, in order that he might make comparative analyses of them and assign to them their relative value as judged from the standpoint of the brewer. The duplicate set of samples was submitted to a well-known firm of hop factors, also with a request to classify them in their order of merit from a market point of view. The samples were submitted for judgment in each case under cipher numbers which afforded no clue to their origin.

We have, therefore, for the last two years, in addition to merely quantitative yields, the scientific verdict of the brewing chemist, and what may be called the market verdict of the hop factor; and it is interesting to compare both the results, the one for a season in which the crop showed itself to be almost wholly dependent, as regards quantity, on the manure supplied to it, and the other for a season in which the hop plant, although not altogether ungrateful for manure, could nevertheless have got on fairly well without it. In such a season as the last it is obviously doubly interesting to ascertain the effect of the manure on quality.

I will first give the results of the chemical analyses of the hops for the two years, viz., determinations of total resins and of soft resin. The results of modern investigation tend to show that it is very largely to the presence and proportion of the latter that hops owe their preserving value, though the quality of hops is by no means wholly dependent on this one feature.

Results of Analysis by Mr. Alfred C. Chapman, F.I.C.

Plot.	Annual dressing per acre.	1898. Total resins. Per cent.	1898. Soft resins. Per cent.		1899. Total resins. Per cent.	1899. Soft resin. Per cent.
A.	Phosphates and potash	14·15	9·21	...	15·07	8·60
B.	Do. do. and 2 cwt. nitrate of soda ...	14·30	9·20	...	16·59	8·83
C.	Do. do. and 4 cwt. nitrate of soda ...	14·06	9·04	...	15·87	9·27
D.	Do. do. and 6 cwt. nitrate of soda ...	13·57	8·60	...	14·90	8·70
E.	Do. do. and 8 cwt. nitrate of soda ...	14·11	8·85	...	14·49	8·96
F.	Do. do. and 10 cwt. nitrate of soda ...	12·21	7·91	...	15·47	9·41
X.	* 30 loads London dung...	13·93	8·66	...	14·92	8·80
S.	Rest of field.—15 cwt. basic slag, 1 ton fish guano, 4 cwt. nitrate of soda ...	13·03	8·30	...	—	—
S.	Rest of field.—20 loads dung, 6 cwt. superphosphate, 6 cwt. nitrate of soda	—	—	...	14·26	8·43
	Another part of the farm.—Dung and guano, without nitrate of soda ...	12·83	8·15	...	—	—
	Another part of the farm.—6 cwt. superphosphate, 2½ tons wool waste, 5 cwt. guano, without nitrate of soda ...	—	—	...	14·51	8·30

* About 15 tons.

Taking into account not only the percentage of resin, but the aroma and general condition, Mr. Chapman considered in 1898 that the best samples were those grown on Plots X, S, C, A, and B. He placed them in this order, but observed that there was practically very little difference between these five samples. He placed the sample from Plot D next in value, and last those from E and F, which he considered to be inferior in value to the others.

The hop factors, who had the duplicate set of 1898 samples, placed B, C, D, and X together, as worth £7 2s. per cwt., placing A, E, F, and S in a somewhat lower class, but valuing them at £6 15s. to £6 18s. in the then current market.

In the case of the 1899 samples, the question of quality possessed, from the point of view of our experiments, even more interest than in 1898, since, from the yields of the plots, it was quite clear that some of the nitrate used must, in this season, have been superfluous as mere plant food, and the

circumstances would seem to afford a good opportunity of testing whether an excess of nitrate—despite there being an abundance of mineral food in the soil—had proved in any way injurious to the quality of the hops. Mr. Chapman was therefore asked to "place" the samples with special care, and his report is as follows, with the exception that the proper letters and descriptions of the plots are now substituted for the arbitrary marks which were placed on the samples themselves, in order that Mr. Chapman might again be entirely unbiassed by any information as to the origin of the samples. Mr. Chapman says:—

"In accordance with your request, I have made a general examination of these samples, with the object of placing them in the order of their value to the brewer, with the following results":—

Plot.	Annual dressing per acre.
F	Phosphates, potash and 10 cwt. nitrate of soda.
S	20 loads London dung, 6 cwt. superphosphate, and 6 cwt. nitrate of soda.
B	Phosphates, potash and 2 cwt. nitrate of soda.
D	,, ,, 6 cwt. nitrate of soda.
E	,, ,, 8 cwt. nitrate of soda.
X	30 loads London dung.
C	Phosphates, potash and 4 cwt. nitrate of soda.
A	Phosphates and potash, without nitrate.
No. 9 (another part of farm).	6 cwt. superphosphate, 2½ tons of wool-waste, and 5 cwt. guano, without nitrate.

"I may say," continues Mr. Chapman, "that although there is a marked difference between the extreme members of the above series, the neighbouring samples resemble one another somewhat closely.

"No. 9 is distinctly inferior in every respect. Its resin percentage is rather low, its aroma is unsatisfactory, and it is very much discoloured.

"In placing these samples I have paid attention to the quantity of condition, the aroma, and general physical characters, as well as to the percentage of preservative resins and the absence of blight and other disease, and, in forming a judgment, have endeavoured to assign to each of these factors that amount of importance which I believe it should possess from the brewer's point of view.

"At present market values I consider 'F' to be worth 60s., and the following six samples would gradually fall to 50s. in the case of 'C.'

"I should not advise any brewer to purchase the last two samples in the present condition of the market."

The duplicates of the samples examined by Mr. Chapman were handed to a well-known firm of hop factors in the Borough, and their report, again substituting the proper descriptions of the samples for the arbitrary numbers under which they were submitted, is as follows :—

FACTORS' REPORT, 1899.

"We have examined the nine samples, and find that taking each individual sample as representing a growth, their values come in the following order :—

"E (Phosphates, potash, and 8 cwt. nitrate of soda.)
S (20 loads London dung, 6 cwt. superphosphate, and 6 cwt. nitrate of soda.)
F (Phosphates, potash, and 10 cwt. nitrate of soda.)
D (,, ,, and 6 cwt. nitrate of soda.)
C (,, ,, and 4 cwt. nitrate of soda.)
B (,, ,, and 2 cwt. nitrate of soda.)
X (30 loads London dung.)
No. 9 (another part of farm) 6 cwt. superphosphate, $2\frac{1}{2}$ tons wool-waste, and 5 cwt. guano, without nitrate.
A (Phosphates and potash, without nitrate.)

"As to their value on to-day's market it is very hard to say within a shilling or two ; but, taking E as being worth 50s. and A 35s. and the other samples in proportion, is as near as it is possible to assess their market value."

It may be added that, on the day on which this valuation was made, 50s. was the full value, to the grower, of what are known as good medium Mid-kent Fuggles.

Judging, therefore, from the quite independent reports of Mr. Chapman and of the hop factors—the one regarding the samples from the ultimate purchaser's point of view, and the other from that of the grower or original vendor—there appears to be no room for doubt that, notwithstanding the very luxuriant growth of the year, the quality of the hops as well as their quantity was materially improved by the liberal use of nitrate of soda.

In looking at the quantitative results, it will be seen that three of the plots were all alike in giving the top yield of $24\frac{1}{2}$ cwt. per acre. These were Plots X (manured with dung only), F (manured with phosphates, potash, and 10 cwt.

nitrate of soda per acre), and S (manured with dung, superphosphate, and 6 cwt. nitrate of soda per acre). F, the plot which received chemical fertilisers only, including 10 cwt. of nitrate per acre, was placed by Mr. Chapman at the head of his list for quality; S, the dressing of which included 6 cwt. of nitrate per acre, came second; while X, manured with dung only, without any nitrate, yielding the same weight of hops, came only sixth in value. On the factor's valuation we get very similar results, S and F coming second and third on the list for quality, while X (dung only) came seventh.

In a year of such general abundance of growth, and consequently of such low average prices as have prevailed for all hops, the money differences represented by differences in the grade of quality are, of course, small as compared with what they would be in a year of high prices. Nevertheless, small differences, from the growers' point of view, are in such a year of even greater consequence than in scarcer and dearer years. A difference of 10s. or 15s. a hundredweight in value when hops are only realising 50s. means a great percentage difference in the money to be turned over. Indeed, in a year of large yields, when purchasers are standing off and growers are eager to realise, a difference in quality which in another year would be regarded as slight may make all the difference between a fairly ready market and no market at all.

The following table shows the acreage value of the crop for each of the plots, based upon the actual weight obtained per acre and upon the values relatively assigned to the growths by Mr. Chapman, judging from the brewers' point of view, and also by the hop-factors as representing the

initial sale value. Although it is the latter valuation that more directly concerns the grower, it is of interest to have the two independent valuations side by side.

FUGGLES HOPS—1899 CROP.

Plot.	Annual dressing per acre.	Yield of hops per acre.	Cost of manuring per acre.		Value of crop per acre on the basis of— Factors' valuation.		Mr. Chapman's valuation.	
		Cwt.	£	s.	£	s.	£	s.
A	Phosphates and potash	$20\frac{1}{4}$	2	10	35	10	—	
B	Do., do. and 2 cwt. nitrate of soda ...	$22\frac{1}{4}$	3	10	45	0	63	0
C	Do., do. and 4 cwt. nitrate of soda...	23	4	10	49	0	57	10
D	Do., do. and 6 cwt. nitrate of soda...	$22\frac{1}{2}$	5	10	50	0	62	0
E	Do., do. and 8 cwt. nitrate of soda ...	$23\frac{1}{2}$	6	10	58	15	62	15
F	Do., do. and 10 cwt. nitrate of soda	$24\frac{1}{2}$	7	10	57	0	73	10
X	†30 loads London dung	$24\frac{1}{2}$	6	0	47	5	63	5
S	Rest of field.—20 loads dung, 6 cwt. superphosphate, and 6 cwt. nitrate of soda	$24\frac{1}{2}$	7	15	59	10	71	10

† About 15 tons.

From these results it appears that, even in this year of abundant growth, nitrate of soda used in liberal quantities not only enhanced the yield, but distinctly improved the quality and intrinsic value of the crop.

In adding this one more year's record to the results published twelve months ago, it is well again to point out that all our experimental years, including 1899, have fallen within the curiously prolonged cycle of years showing a deficiency of average rainfall. I hope, however, with the aid of Mr. Shrivell, to continue the experiments for a number of years to come, and in this way to be able to see how the various dressings comport themselves in wet as well as in dry summers.

Readers will, of course, bear in mind that, except on Plots X and S no nitrogenous manure other than nitrate of soda has been applied to our experimental plots. Now, as I have already in effect observed, it is neither convenient nor desirable that hops, more than any other crop, should be

restricted to one form of manuring. A hop farmer will naturally, and rightly, give his hops as much dung as his farm resources will supply; though I must say I have grave doubt as to the economy, under most circumstances, of buying town dung, unless on specially favourable terms as regards cost of conveyance. There is a large variety of other nitrogenous manures in the market, such as Peruvian and Damaraland guano, sulphate of ammonia, fish guano, dried blood, rape dust, furriers' refuse, horn shavings, hoof-parings, wood dust, shoddy, &c. All of these may, turn and turn about, be used for helping to maintain a stock of nitrogen in the soil, and the degree to which manures of this kind have been recently applied to any hop garden will naturally influence the grower in deciding as to the quantity of nitrate of soda he should use in conjunction with them, and also to some extent in deciding as to the date of its application.

Dressings of 8 cwt. and 10 cwt. per acre, such as we annually give to plots E and F, would be larger than would be applied where the land had been already dressed with dung or with other nitrogenous manures. It has been seen, however, that 6 cwt. of nitrate per acre did not prove too much on the main portion of our experimental field in the past season, although 20 loads of dung per acre were used, following a ton of fish guano and 4 cwt. of nitrate of soda per acre applied in the previous season. In our experience, therefore, even following recent liberal manuring with nitrogen in other forms, 6 cwt. of nitrate of soda per acre has not proved itself to be in any way deleterious to the quality of the produce in a dry season, although growth was naturally luxuriant; in fact, it gave the best result of all our plots. If asked for a general opinion as to the safe limit

in case a season should turn out to be wet, I should say that, on a soil otherwise liberally manured, 4 cwt. of nitrate per acre would be a thoroughly safe dressing. In the case of neither dung nor any other nitrogenous fertilisers having been recently applied, I see no reason for anticipating that, even in a wet season, 6 cwt. of nitrate of soda per acre would be otherwise than a safe dose.

As to the time of application, the present opinion of Mr. Shrivell and myself is that April or May is the latest time at which nitrate should be applied, and we are inclined to prefer April to May. The quantity used should be applied in separate dressings of not more than 2 cwt. per acre at each time, put on at intervals of a month. Where the quantity of nitrate used is large, and constitutes the whole of the nitrogenous manure employed, the first dressing may, on fairly deep and retentive soils, be given as early as January; or, if the quantity used is smaller, say in February; while February will in most cases probably be early enough for the first dressing in the case of lighter soils. The condition of the soil, and the degree and distribution of rainfall during both the previous autumn and the winter, as well as in the spring itself, produce such varying conditions that it is almost impossible to frame generally applicable rules.

It has been generally supposed that nitrate of soda is a manure which should be reserved for use during the latter period of the growth of the bine. Now the summer months, when the growth of the bine is most active, are the months in which natural nitrification is at work in the soil, converting soil nitrogen and the nitrogen of dung, guano, fish, rape dust, shoddy, or other fertilisers into nitrates, and placing this nitrogen at the disposal of the plant; and it appears reason-

able, therefore, to suppose that nitrate of soda itself will be more grateful to the hops at the earlier stages of their growth, before the products of natural nitrification become abundant. If we can get at any rate a considerable proportion of our nitrate of soda well incorporated with the soil by the time the bine begins its active and rapid growth, we may be helping to lay the foundation of a good crop better than if we delay the application of the nitrate until those months when the soil is actively producing nitrates from other sources. This policy would appear especially to hold good after a wet autumn and winter, which would have had the effect of washing away the residual nitrates unutilised by the previous crop.

In concluding this report I would once again emphasise the necessity, whether dung is used or not, and whatever form of nitrogenous manure is employed, of also using an abundance of phosphates. On soils containing plenty of lime, no better or cheaper phosphatic manure can be used than superphosphate, of which 8 cwt. per acre per annum makes a fair dressing. But if the soil is not decidedly calcareous—that is to say, if it does not effervesce when it is stirred up with some diluted hydrochloric (muriatic) acid—basic slag, bone dust, or guano should be used as a source of phosphates, at the rate of not less than ½ ton per acre. On medium soils which, without being distinctly calcareous, nevertheless contain a just appreciable proportion of carbonate of lime, it is probably a good plan to use the latter class of manures alternately with superphosphate. But it is wise policy to use phosphates in some form or other every year in every hop garden. They are inexpensive, and without them neither dung, nitrate of soda, ammonia salts, nor organic manures can be expected to

produce both a full vigorous growth of bine and well-matured, full-weighted hops.

The use of potash salts is probably on most soils not needed, where dung is pretty constantly used; but where this is not the case, their aid should not be neglected.

17, *Great Tower Street, London,*
January, 1900.

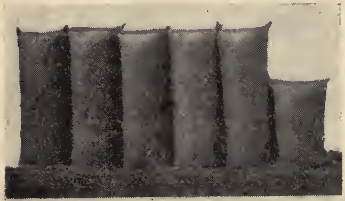
For Photographic Illustrations of Crops,

see next two pages.

1898 CROP.

EACH ROW OF POCKETS SHEWS THE PRODUCE OF ONE ACRE.

Plot



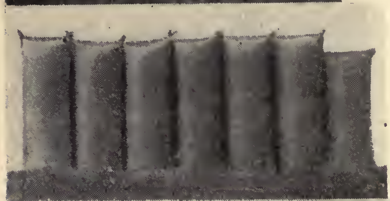
A

8 cwt. Superphosphate.

1 cwt. Sulphate of Potash.

No Nitrate.

Produce: $8\frac{1}{4}$ cwt. per acre.



B

8 cwt. Superphosphate.

1 cwt. Sulphate of Potash.

2 cwt. Nitrate of Soda.

Produce: $10\frac{1}{4}$ cwt. per acre.

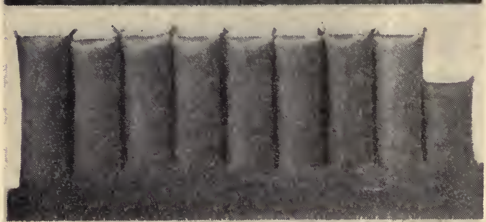
C

8 cwt. Superphosphate.

1 cwt. Sulphate of Potash.

4 cwt. Nitrate of Soda.

Produce: $12\frac{1}{2}$ cwt. per acre.



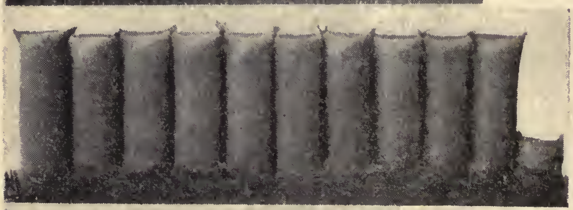
D

8 cwt. Superphosphate.

1 cwt. Sulphate of Potash.

6 cwt. Nitrate of Soda.

Produce: 13 cwt. per acre.



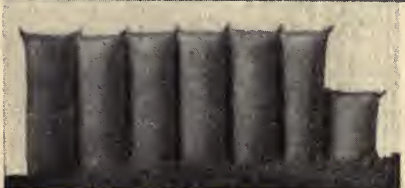
E

8 cwt. Superphosphate.

1 cwt. Sulphate of Potash.

8 cwt. Nitrate of Soda.

Produce: $15\frac{1}{4}$ cwt. per acre.



X

15 tons Dung per acre.

Produce $9\frac{3}{4}$ cwt. per acre.

AVERAGE OF FOUR YEARS' CROPS,

1896-1899.

EACH ROW OF POCKETS SHEWS THE AVERAGE ANNUAL PRODUCE OF ONE ACRE.

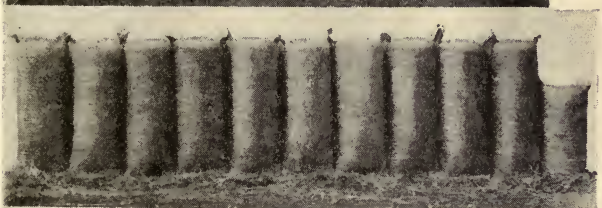
Plot

A Phosphates and Potash. No Nitrate.

Produce: 12½ cwt.

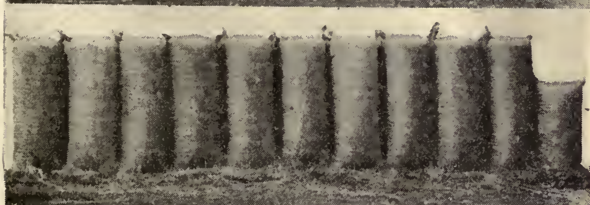
B Phosphates, Potash and 2 cwt. Nitr. of Soda.

Produce: 14½ cwt.



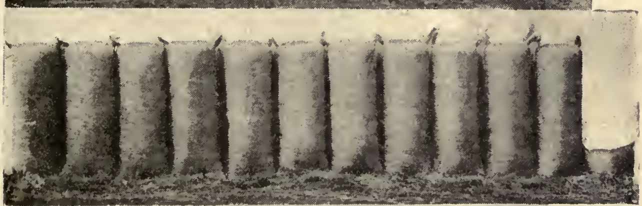
C Phosphates, Potash and 4 cwt. Nitr. of Soda.

Produce: 16 cwt.



D Phosphates, Potash and 6 cwt. Nitr. of Soda.

Produce: 16 cwt.



E Phosphates, Potash and 8 cwt. Nitr. of Soda.

Produce: 16¾ cwt.

X 15 tons Dung per acre.

Produce: 13¾ cwt.